

**REMARKS**

The claims have been amended in order to more particularly point out and distinctly claim the subject matter which Applicants regard as the invention and to place the claims in better form for consideration on appeal. Newly presented Claims 16-22 are directed to preferred embodiments of the present invention. No new matter has been added. Favorable consideration is respectfully solicited.

Claims 13 and 14 have been rejected under 35 USC 112, second paragraph, as being indefinite. These claims have been amended in order to address the Examiner's rejection. Claims 5 and 8-12 have been rejected under 35 USC 102(b) as being anticipated by or, in the alternative, under 35 USC 103(a) as obvious over Sudhakar et al. Claims 13 and 14 have been rejected under 35 USC 103(a) as being unpatentable over Sudhakar et al. Claims 6, 7 and 15 have been rejected under 35 USC 103(a) as being unpatentable over Sudhakar et al and further in view of Simpson et al and Adams et al. Applicants respectfully traverse these grounds of rejection and urge reconsideration in light of the following comments.

In its broadest form, the presently claimed invention is directed to a method of hydrocracking a heavy oil including at least one of asphaltene, residual carbon, nickel and vanadium in a reactor comprising the steps of contacting the heavy oil with a catalyst comprising iron and active carbon having an MCH conversion rate of 40-80%, specific surface area of 60-1000 m<sup>2</sup>/g, pore volume of 0.5-1.4 cm<sup>3</sup>/g, 2-50 nm mesopore volume of not less than 60% and average pore diameter of 3-6 nm, the iron being carried on the active carbon in an amount of 1-20 wt.% with respect to the active carbon.

As discussed previously, the present invention is based on the discovery that the claimed catalyst can be used in the hydrocracking of a heavy oil including at least one of asphaltene, residual carbon, nickel and vanadium and can produce a hydrocracked product containing a lower amount of nickel and vanadium while preventing coke from being generated

in a side reaction during the hydrocracking. The heavy oil feed of the present invention can include a heptane-insoluble matter in an amount of 9-30 wt.%, nickel and/or vanadium in a total amount of from 200-1000 parts per million by weight and fractions having a boiling point not lower than 525°C in an amount of 70-100% by volume.

In an embodiment of the present invention, two hydrocracking steps are performed in which the first step is conducted at a lower temperature than the second step. This helps to prevent the generation of coke due to the hydrocarbon radicals being controlled in the first step and polycondensation between the hydrocarbon radicals being suppressed. In the present invention, the catalyst is not deactivated with impurities contained in the heavy oil, such as aroma, nitrogen compounds, asphaltene and heavy metals such as nickel or vanadium, and coke is prevented from being generated. It is respectfully submitted that the presently claimed invention is clearly patentably distinguishable over the prior art cited by the Examiner.

The Sudhakar et al reference is directed to a process for pre-treating a hydrocarbon oil feed containing sulfur and nitrogen compounds and aromatics prior to hydrocracking or fluid catalytic cracking. The disclosed process involves the step of contacting the feedstock with a sulfided catalyst comprising a metal of non-noble Group VIII and Group VIB, and, optionally one or more elements selected from Group IIIA and Group VA of the Periodic Table on a carbon support consisting essentially of activated carbon and, optionally, on a carbon support treated with phosphorus.

In Sudhakar et al, the charged hydrocarbons include hydrocarbon oil feeds generally heavier than kerosene, including, but not limited to all atmospheric gas oils, all vacuum gas oils, residual and whole crude oils, heavy naphtha and may also be derived from petroleum, coal, shell, tar sands, oil sands and other synthetic fuels. However, the only examples shown in this reference use gas oils which inherently

do not include either nickel or vanadium. In this reference, the gas oil is modified to remove matters which cause the side-production of coke in a step of hydrodearomatization. If the distillation residual oil of the present invention was treated according to this process, coke would be produced as a side-product. This reference further discloses that the catalyst can carry a metal of both Group VIII and Group VIB. There is no specific disclosure of anything advantageous occurring by using iron as the catalytic metal. Moreover, this reference fails to disclose any problems resulting from impurities such as heavy metals, nickel, vanadium or asphaltene because gas oils do not contain these impurities.

The carbon used in Sudhakar et al is a commercially available activated carbon which is treated with phosphorous acid or a carbon activated with phosphorus acid. As shown in the enclosed reference denoted as "2", carbon treated with phosphorous acid has an acidic character. In contrast thereto, as shown in the enclosed literature "1", carbon activated by gas, such as steam, carbon dioxide, oxygen or air, at a high temperature is basic while carbon activated with a chemical such as phosphorous acid at a low temperature has an acidic character which does not make it suitable for the hydrocracking of heavy oils. Literature "3" shows that oil to be treated with hydrocracking includes aromatic hydrocarbon compounds, called aroma, nitrogen compounds, asphaltene and heavy metals such as nickel or vanadium and the higher the boiling point, the more impurities it has. It is known to a person of ordinary skill in the art that these impurities are basic. Literatures "4" and "5" illustrate that a conventional catalyst for hydrocracking includes an acidic carrier such as alumina or silica and the acidity will improve the hydrocracking activity. A high acidity is preferred and the heavy oil includes heavy boiling point fractions which are basic and the basic property of these heavy oils will work to deactivate the acidic catalyst. Literature "6" shows that the more acidic the catalyst is, the more coke will be generated

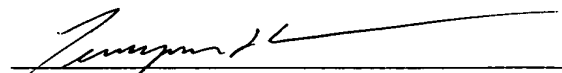
and, for this reason, the addition of an alkali metal decreases the acidity of the catalyst to suppress the generation of coke.

For the reasons discussed above, the catalyst of Sudhakar et al is an acidic catalyst having a high hydrocracking activity for reducing aroma and nitrogen for gas oil, which only has a low content of basic impurities. The acidic catalyst of Sudhakar et al is not effective in the hydrocracking of heavy oils having basic compounds in a high concentration, such as aroma, nitrogen compounds, asphaltene and heavy metals such as nickel or vanadium. Additionally, a large amount of coke would be generated using the catalyst of Sudhakar et al in the hydrocracking of heavy oils containing impurities. Therefore, it is respectfully submitted that the presently claimed invention is clearly patentably distinguishable over this reference.

The Simpson et al and Adams et al references have been reviewed and while Applicants do agree with the Examiner's characterization of what these references individually disclose, these references do not cure the basic defects in the primary Sudhakar et al reference and provide the motivation to one of ordinary skill in the art to use the claimed catalyst having a basic character as opposed to the acidic catalyst of Sudhakar et al. Therefore, it is respectfully submitted that the presently claimed invention is patentably distinguishable over Sudhakar et al in combination with the secondary references.

The Examiner is respectfully requested to reconsider the present application and to pass it to issue.

Respectfully submitted,

  
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Encl: Literatures 1-6  
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